The BARREL SEED SCARIFIER

LEAFLET
NO. 107

UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D. C. Issued November 1934

THE BARREL SEED SCARIFIER[1]

By W. M. Hurst, *associate agricultural engineer*, and W. R. Humphries, *chief engineering aid, Division of Mechanical Equipment, Bureau of Agricultural Engineering*, and Roland McKee, *senior agronomist, Division of Forage Crops and Diseases, Bureau of Plant Industry*

Need For Seed Scarifier

The seed of some legumes have a hard coat which is impervious to the action of moisture necessary for germination. When such seed is planted only a small percentage—often as low as 5 to 10 percent—will germinate within a reasonable length of time. In order to increase germination, the seed coat must be ruptured in some manner to facilitate the absorption of moisture.

Machines used for rupturing the seed coats of hard seed are known as scarifiers, and such devices have been on the market for a number of years. Seed scarifiers usually do the work for which they are designed, but farmers with only a few bushels of seed to scarify each season do not feel justified in purchasing a machine. An attempt was therefore made by the Bureaus of Agricultural Engineering and Plant Industry to develop a home-made scarifier suitable for use in scarifying small lots of seed on farms.

Tests with a Barrel Scarifier

Ball mills or tumblers in which steel balls or irregular-shaped objects are used for polishing, crushing, or pulverizing certain materials have been used for many years. These machines are usually very simple in design and construction, and comparatively little power is required to operate them. Preliminary investigations in which gravel was used as an abrasive in a tumbler indicated that the principles involved in ball mills might be used in hulling and scarifying certain seed. An experimental scarifier of this type, consisting of a barrel mounted in a frame with provision for rotating it in a horizontal position, was set up at the Arlington Experiment Farm, Va., in 1932. Preliminary tests indicated that such a device might be used but that its effectiveness in scarifying seed depends in part upon the size of gravel, the proportion of seed and gravel, and the speed at which the barrel is revolved. Tests were then made to determine what effect these variables have on the performance of such a machine in scarifying *Crotalaria striata*, *Lespedeza sericea*, and sweetclover (*Melilotus officinalis* and *M. alba*) seed.

---

[1] The investigations on which this leaflet is based were conducted by the Bureau of Agricultural Engineering, in cooperation with the Bureau of Plant Industry.

81847°—34

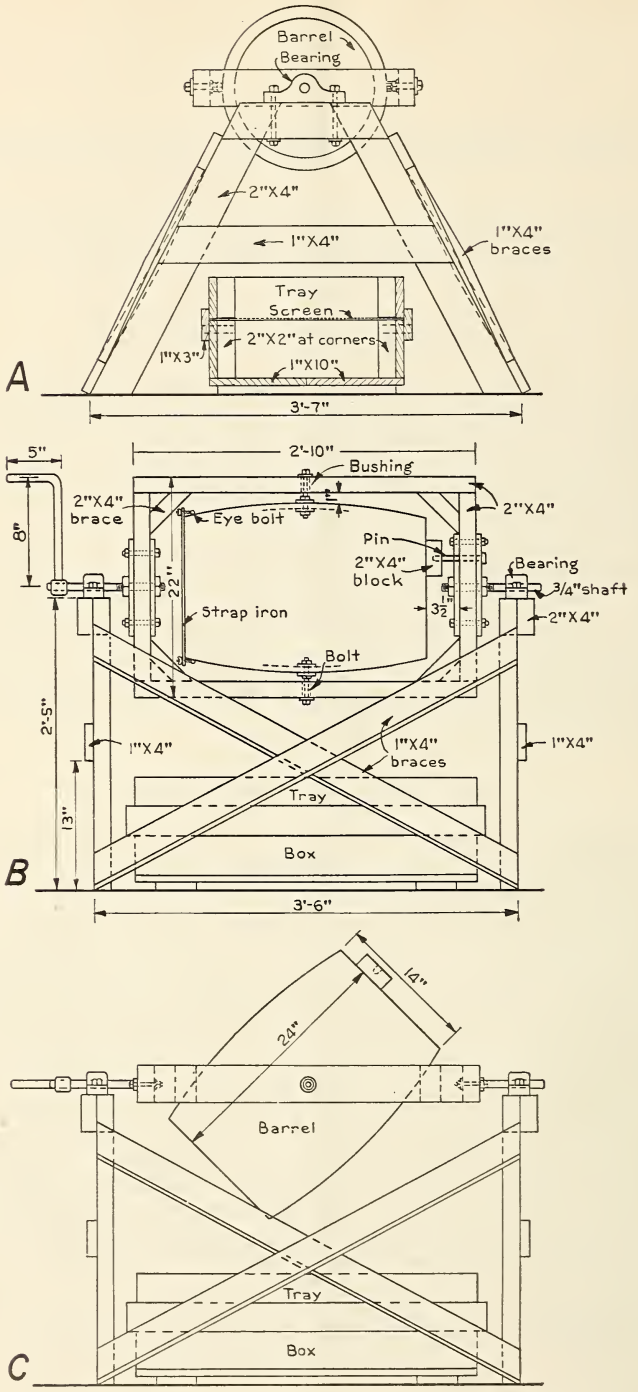

FIGURE 1.—Dimension drawing of hand-driven barrel scarifier, using 15-gallon barrel mounted in a rotating frame so it can be tilted for filling and emptying: *A*, end elevation; *B*, side elevation, showing barrel in horizontal position; *C*, side elevation, showing barrel tilted for emptying or filling.

Construction of a Barrel Scarifier

A barrel for use as a scarifier may be supported on a frame as shown in figure 1, and the cover illustration. The barrel is mounted in a rectangular frame and so pivoted as to facilitate filling and emptying the barrel. When in operation it is held in a horizontal position by a pin extending through one end of the frame into a 2- by 4-inch block attached to the bottom of the barrel.

The barrel used for the scarifier should be of heavy construction, and practically watertight. Pieces of strap iron are bolted to the barrel both inside and out, on opposite sides, through which holes are drilled to receive bolts. These bolts, one on each side, extend through bushings in the frame, forming a support and a pivot for the barrel. The frame is supported on bearings at each end.

In constructing the rectangular frame, care should be exercised to get the sides parallel and at right angles to the end pieces. It is also important that the shaft supports for the frame be located at the exact center of each end piece. A slight variation in this will cause the frame to wobble when being revolved, require greater power, and subject the frame and bearings to undue vibration. Special attention should also be given to obtaining a tight fit of the top or head of the barrel. The seed of some legumes are very small and will sift out through a very small crack. In case a tight fit is difficult to obtain, a piece of heavy cloth may be placed over the end of the barrel before the head is put in place.

The seed may be separated from the gravel by dumping the contents of the barrel into a screen-bottom tray placed on top of a box or other container suitable for collecting the seed. Hardware cloth of ¼-inch mesh may be used for the bottom of the tray. The tray will retain the gravel, and the seed will fall through the screen if the gravel and seed are placed in a layer only a few inches deep and stirred slightly. A screen-bottom tray and box for separating the seed and gravel and collecting the seed are illustrated in figure 1.

Operation of scarifier

The barrel may be operated either by hand or with mechanical power, and the speed at which it should be turned will depend on the size of the barrel. The smaller the barrel the faster it may be operated without causing the seed and gravel to whirl. Obviously, if the seed and gravel do whirl with the barrel, little or no scarifying action will result. The tabulation on page 4 gives the recommended speed in revolutions per minute for barrels of different sizes. The maximum speed indicated for each size is slightly below the speed at which centrifugal action may cause some of the seed and gravel to whirl. Barrels are not standardized as to capacity or dimensions, and probably few would have just the diameters shown in the tabulation, but the range given is sufficient for determining the proper speed of practically any barrel that might be suitable for scarifying seed.

Size and quantity of gravel

Gravel that will pass a ¾-inch but be retained on a ½-inch mesh screen probably will give best results on most seeds. The larger the

gravel the more rapid is the hulling and scarifying action, but if it has particles much larger than one-half inch some of the seed may be severely injured. The gravel should be screened, washed, and allowed to dry before being used. An aggregate generally known as "river-run gravel" was used by the authors for the tests referred to in this leaflet. If the particles have sharp edges or if a different kind of abrasive is used, germination tests should be made with samples of seed before a large portion of any lot of seed is scarified; otherwise, the entire lot may be damaged.

The approximate germination of any lot of seed can be determined easily by placing a sample of the seed between moistened blotting paper or by rolling it in a damp cloth and keeping it at a temperature of about 70° F. The cloth or blotting paper should be kept moist during the germination period. In a kitchen or living room the temperature is usually favorable. Under these conditions the percentage of germination usually can be determined in 6 to 8 days.

Diameter of barrel:	*Range in speed (revolutions per minute)*
1 foot	60–75
1.5 feet	50–60
2 feet	40–50
3 feet	30–40
4 feet	25–35

Any proportions of seed and gravel may be used, but as the proportion of seed is increased the time required for scarification also is increased. Results of tests made on *Crotalaria striata*, *Lespedeza sericea*, and sweetclover seed indicate that the best results may be expected when the volume of gravel is 1 to 2 times the volume of seed. The barrel should not be filled more than half full of seed and gravel.

So far as available data show, the quantity of material in the barrel, provided it is not filled more than half full, has little effect on the time required for scarification with any particular proportions of seed and gravel. In other words, seed and gravel mixed 1 part seed and 2 parts gravel by volume should give about the same results whether the mixture fills the barrel one-quarter or one-half full.

Duration of Treatment

Table 1 gives the duration of treatment from which maximum germination was obtained for *Crotalaria striata*, *Lespedeza sericea*, and sweetclover when different proportions of seed and gravel were used in the barrel.

TABLE 1.—*Duration of treatment for maximum germination with ½- to ¾-inch gravel and different proportions of crotalaria, lespedeza, and sweetclover seed*

Kind of seed	Proportion by volume of seed and gravel	Time in barrel for maximum germination
		Minutes
Crotalaria	1:6	10–20
	1:3	40–60
	1:2	40–60
Lespedeza	1:6	20–30
	1:3	30–40
	1:2	40–50
	1:1.5	60–70
Sweetclover	1:6	15–20
	1:3	20–30
	1:2	30–40
	1:1.5	

The duration of treatment required for best results will vary with the kind of seed, the proportions of seed and gravel, and the size of gravel, and probably with the type of gravel and the moisture content of the seed. With ½- to ¾-inch gravel, sweetclover and lespedeza should be tumbled until practically all of the seed are hulled, at which time the seed will be sufficiently scarified. With crotalaria, it is suggested that table 1 be used as a guide because the degree of scarification cannot be accurately determined by observation.

From 50 to 75 percent of crotalaria seed scarified in a barrel scarifier should be expected to germinate. Sweetclover seed of high viability should germinate at least 90 percent, and lespedeza from 90 to 95 percent. Germination in this connection refers to seedlings capable of producing normal plants.

Using a Concrete Mixer

In case a farm-size concrete mixer is available, it may be used as a seed scarifier. The same size gravel and approximately the same proportion of seed and gravel should be used in a concrete mixer as in a tumbling barrel. In scarifying seed, however, it is necessary to operate the mixing bowl with the axis more nearly horizontal than is customary in mixing concrete. When operated as recommended, the seed and gravel picked up by the mixing blades have a greater distance to fall and the scarifying action is more rapid than when the bowl is set as for mixing concrete.

U. S. GOVERNMENT PRINTING OFFICE: 1934

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents